EMULSION FUEL AND METHOD OF PREPARING THE SAME

Field of the Invention

The present invention relates to an emulsion fuel prepared by adding water to common heavy oil such as bunker fuel oil C and petroleum. More particularly, the present invention relates to an emulsion fuel as an alternative energy fuel by emulsifying common heavy oil with a catalyst after adding water to the heavy oil.

Background of the Invention

There are a lot of efforts and developments in the world to lessen an amount of sulfur in a fuel and to convert a solid fuel to a liquid or gaseous fuel in view of saving energy and preventing air-pollution. Specially, the air-pollution caused by a petroleum fuel is very serious due to its harmful influence on an ecosystem. Although there are invisible trade barriers with WTO (World Trade Organization), OECD (Organization for Economic Cooperation and Development) and GR (Green Round) founded or contracted, the developments for suitable alternative fuels are not sufficient.

The emulsion fuel made by adding water to fuel oil has been studied in Europe since around 1950 and then started the trial to improve combustibility and save fuel. Recently, in regard to the emulsion fuel there are so many researches in U.S.A. and Japan.

During World War II, using aviation gasoline to which added water the airplane engine produced strengthened output. There are so many possibilities for reducing the air-pollution and improving combustion efficiency by studying and testing the emulsion fuel.

Objects of the Invention

It is an object of the present invention to provide a novel emulsion fuel having a good effect on reduction of energy consumption and prevention from anti-pollution by emulsifying fuel by means of adding water to common fuel oil (heavy oil) applied to an industrial boiler or furnace.

Another object of the present invention is to provide an emulsion fuel that can prevent air-pollution and obtain commercial benefit by dissolving sludge contained in heavy oil minutely, burning the emulsified fuel oil that is made by the added water being ultra-particles and then facilitating complete combustion through hydrogen gas reaction and fine explosion.

Still another object of the present invention is to provide an emulsion fuel that can prevent air-pollution and dispense with fuel by preventing smoke, dust, carbon monoxide, hydrocarbon and so on from being formed by decreasing excess air rate, and can lessen conversion rate of SO_2 to SO_3, and change combustion flame to white-hot and increasing radiation heat.

Still another object of the present invention is to provide a method of preparing the emulsion fuel.

Other objects and advantages of this invention will be apparent from the ensuing disclosure and appended claims.

Summary of the Invention

The emulsion fuel according to the present invention is prepared by emulsifying about 55 to 90 % by weight of a mixture of heavy oil, 45 to 10 % by weight of water, and 0.3 to 0.8 % by weight of a catalyst. The catalyst comprises caustic soda (sodium hydroxide) and calcium dichloride in half and half. The calcium chloride can be partly substituted with calcium sulfate.

Detailed Description of the Invention

The emulsion fuel according to the present invention stems from green pine leaves that commonly used as a winter fuel in some agricultural districts of Korea. The green pine leaves comprise 90% of water, and 10% of pine oil and other minimal organic combustibles. Because the green pine leaves burn very actively and have a high thermal efficiency during combustion, they are suitable for the Korean under-floor heating system.

Just as the green pine leaves comprises 10% of pine oil and 90% of water, the emulsion fuel of the present invention can be prepared by emulsifying common heavy oil such as bunker fuel oil C with water. Also, the catalyst compound of the present invention have invented owing to the property that a sodium hydroxide can be soluble oil in water and that calcium or bittern containing the calcium solidify proteins. By using the catalyst compound, a mixture of heavy oil and water can be emulsified in the present invention.

For example, the green pine leaves in which 10% of pine oil in 90% water is dissolved can be easily burned and have a good efficiency. However, in case of permeating 50% of water into completely dried pine leaves, the leaves did not get even ignited. The reason is that the permeated 50% of water exists as water itself, not a soluble compound of pine oil and water as in case of the green pine leaves.

The compound prepared by mixing 10 to 45 % by weight of water and 90 to 55 % by weight of heavy oil such as bunker fuel oil C and petroleum in the presence of the catalyst in accordance with the present invention is kind of combustible material different from water. The molecule structure of the catalyst comprises an alkyl part that is affinitive with oil and a part that is affinitive with water, that is, the catalyst has both a hydrophobic and a hydrophilic group. Thus, between an oil layer and a water layer, because of the catalyst having a hydrophobic group and a hydrophilic group, hydrophobic molecules is placed at the oil layer, hydrophilic molecules at the water layer by attraction force. In consequence, the emulsification occurs to change properties of an interface or surface of water and oil by surface

activities.

The catalyst of the present invention is composed of sodium hydroxide and calcium dichloride. The calcium dichloride can be partly substituted by calcium sulfate. Adding 50% of a sodium hydroxide aqueous solution into 50% of a calcium dichloride slowly through a netting fabric, a white compound whose shape is like a thickening agent is educed by chemical interaction between the sodium hydroxide and calcium dichloride. Drying the compound on a netting thread having good water permeability, it becomes minute powders that have no tastes.

The emulsion fuel according to the present invention is prepared by emulsifying with mixing 55 to 90 % by weight of heavy oil such as bunker fuel oil C and petroleum and 45 to 10 % by weight of water, and adding 0.3 to 0.8 % by weight of catalyst. Adding 45 to 10 % by weight of water and the catalyst to fuel oil, the water is changed into minute droplets having less than 10 micron of diameter and the water becomes water droplets in oil. With the water droplets contained in the jetted oil droplet being heated and expanded in a furnace, the water droplets are vaporized explosively, disperse the emulsion fuel in all directions and then can facilitate complete combustion of fuel.

In general, the ultra-particle sized emulsion fuel can burn completely by reducing an amount of excess water and increasing the contact surface area. And, a cooling reaction of fire by the latent heat caused by vaporization of water, and a reaction to carbon of water bring to reductive effect of combustion carbon. Also, the contents of NO_x and hydrocarbon are reduced by chemical and physical reaction thereof. The emulsion fuel has an excellent fuel supplying and jetting as a colloid.

When the emulsion fuel that contains oil and water droplet burns, the water droplet contained in the oil droplet is exploded and vaporized with being heated at high temperature and expanded rapidly. Then the water droplet is continuously exploded, the ambient fuel is dispersed minutely in all directions. Thus, the continuous minute explosive reaction brings complete combustion of the fuel.

The water droplet of the emulsion fuel has a diameter of about 10 microns, 10 to 30 % of water, and many of microns of water droplets in oil droplets. For

example, the number of water droplets having diameters of 3 microns is about 900 when 50 microns is a diameter of an oil droplet of the emulsion fuel whose water contents are 20%.

In case of LPG, the combustion gas includes 19 to 20 % of water and that is similar with the emulsion fuel. The combustion efficiency of the present emulsion fuel is even higher than that of LPG gas.

The reaction formula of the water is $C+H_2O \rightarrow CO+H_2 (+O_2) \rightarrow CO_2 + H_2O$, and that is the reaction of water gas. Water molecules react with fuel oil at high temperature and then CO and H are generated. The combustion efficiency increases due to the reduction of the carbons.

An oxidized nitrogen generated in combustion is almost NO and NO_2. Both NO and NO_2 are called NO_x. The water of the emulsion fuel having uniform particles, it prevents generation of local high temperature region and decreases combustion temperature by means of vaporization latent heat of 20 to 30 % by volume of water. The water particles then prevent generation of NO_x with absorption of heat, and generation of local high temperature region by reaction of carbon particles and water gas. This NO_x reduction results in prevention of air-pollution.

When the emulsion fuel of the present invention is applied to domestic or industrial boilers, NO_x generation can be reduced by 40 to 75 %. The expanded surface areas of the particle sized water droplet facilitate air-contact, and complete combustion can be accomplished with a little air contents and practically more than 50 % of smoke is reduced. Also, the concentration of smoke dusts is also reduced. For the most part, adding 50 % of water decreases the concentration of smoke dusts by half. The emulsion fuel of the present invention can reduce pollution because of remarkable reduction of smoke and can reduce the energy fuel by 30% because of reduction of the excess air rate.

Generally, gas fuel burns with a transparent flame and heavy oil burns with a transparent and yellow flame, which is in the presence of floating carbons. However, the present emulsion fuel burns like the gas fuel with a flame.

Adding water to fuel oil, an amount of combustion gases increase by

multiplying a weight of added water by 22.4/18 (Nm^3/kg). A temperature of the flame is decreased by about 100 ℃ when water is added by 30 to 50 % based on combustion with 1.2 of lamp-oil over air. However, because the amount of combustion gases increase, a heat transfer effect is not decreased. The combustion gases generated by combustion of liquefied fuel (e.g. LPG or LNG) include about 13 % of water. By adding water to the fuel the water contents become 16 to 17 %. The emulsion fuel has no corrosion problem because the liquefied fuel that contains similar concentration of water with that of the emulsion fuel has no such kind of problem. Although there is little heat loss occurred by the added water, the thermal efficiency is increased owing to the decrease of air rate, smoke, pollution and so on, and the effect that can prevent NO_x from being generated.

The emulsion fuel is dispersed in a burner actively and the rate of the combustion gets more faster since combustion flames of oil droplets that have ultra-particles with water becomes a single flame. Because the fuel becomes more minute particles and then is dispersed again, the particles of the water is exploded continuously by high temperature. Thus, complete combustion can be accomplished by forming combustion flame like complete particle gases.

The present invention may be better understood by reference to the following examples that are intended for the purpose of illustration and are not to be construed as in any way limiting the scope of the present invention, which is defined in the claims appended hereto. In the following examples, all parts and percentage are by weight unless otherwise indicated.

Examples

Example 1

After mixing 60 % by weight of bunker fuel oil C containing less than 0.5 % of sulfur with 40 % by weight of water, 0.5 % by weight of catalyst compound was

added based on the weight of the entire composition. The catalyst compound comprised caustic soda and calcium dichloride in half and half. The present emulsion fuel was prepared by emulsifying the mixed composition using an emulsifier.

Example 2

The Example 2 was put to the test in the same manner as in Example 1, except that 70 % by weight of bunker fuel oil C and 30 % by weight of water were used.

Comparative Example 1

The emulsion fuel was prepared with no water and 1.0 % by weight of sulfur was used.

Comparative Example 2

The emulsion fuel was prepared with no water and less than 0.5 % by weight of sulfur was used.

The test was performed with a smoke tube packaged boiler continuously operated under more than 90 % of loading rate. The analyses for the emulsion fuel and air-pollutants was carried out and the volume of the supplying oil, the exhaust gas and so on were measured. The analyzed results regarding Example 1 and 2, and Comparative Example 1 and 2 were recorded on the below Table 1, and the performances on the below Table 2. The tables showed that the emulsion fuel according to the present invention, such as Example 1 and 2, had good results and performances.

Table 1

Analyzed subjects		Unit	Example		Comparative Example	
			1	2	1	2
Higher calorific value		kcal/kg	8,940	9,720	10,300	10,520
Water content		vol.%	12.0	7.0	3.2	below 0.05
Dynamic viscosity		40℃, cSt	385	308	308	287
Residual carbon powder		wt, %	3.94	5.11	7.21	6.53
Specific gravity		15/4℃	0.9559	0.9496	0.9541	0.9453
Ash contents		wt, %	0.29	0.21	0.013	0.002
Sulfur contents		wt, %	0.41	0.42	0.77	0.49
Metal Contents	Cadmium (Cd)	Ppm	-	-	-	-
	Lead (Pb)	Ppm	-	-	-	-
	Chrome (Cr)	Ppm	-	-	below 1	-
	Arsenic (As)	Ppm	-	-	-	-
	Calcium (Ca)	Ppm	20	49	2	-
	Magnesium (Mg)	Ppm	26	12	below 1	below 1
	Phosphorus (P)	Ppm	-	-	-	-
	Zinc (Zn)	Ppm	1	1	1	1

Table 2

Measured subjects		Unit	Example		Comparative Example	
			1	2	1	2
Fuel consumption		L/Hr	260	259	247	249
Supplying oil temperature		℃	89	89	89	89
Specific gravity of fuel oil		15/4℃	0.9559	0.9496	0.9453	0.9541
Converted fuel consumption		Kg/Hr	236	233	222	226
Supplying water flow rate		L/Hr	2,982	3,074	3,134	2,880
Supplying water temperature		℃	17	20	19	20
Specific gravity of supplying water		Kg/m^3	998.7	998.2	998.4	998.2
Converted vaporization		Kg/Hr	2.978	3.068	3.129	2.875
Vapor pressure		Kg/cm^2	3.2	3.2	3.3	3.2
Exit temperature of a boiler		℃	244	252	244	240
Exhaust Gas (at the exit of a multi-cyclone)	Gas temperature	℃	228	238	217	220
	O2 contents	%	2.82	2.14	2.69	2.85
	Fixed pressure	mmH_2O	-1.5	-1.5	-1.0	-1.3
	Dynamic pressure	mmH_2O	5.3	5.1	5.2	5.2
	Gas density	Kg/m^3	0.708	0.695	0.721	0.720
	Gas velocity	m/sec	10.18	10.08	10.02	10.00
	Cross-sectional area of a duct	m^2	0.16	0.16	0.16	0.16
	Gas flow rate	m^3/hr	5,860	5,810	5,770	5,760
		Nm^3/hr	3,190	3,100	3,210	3,190

The present invention can provide an emulsion fuel having a good effect on reduction of energy consumption and prevention from anti-pollution by emulsifying fuel by means of adding water to common fuel oil applied to an industrial boiler or furnace. Also, the present emulsion fuel can prevent air-pollution and obtain commercial benefit by dissolving sludge contained in heavy oil minutely, burning the emulsified fuel oil that is made by the added water being ultra-particles and then facilitating complete combustion through hydrogen gas reaction and fine explosion.

While the present invention has been described with reference to the

particular illustrative embodiments, it is not to be restricted by the embodiments but only by the appended claims. It is to be appreciated that those skilled in the art can change or modify the embodiments without departing from the scope and spirit of the present invention.

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